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IIASA Interim Report
May 2006

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IIASA Interim Report IR-06-019

Emission scenarios for methane and nitrous oxides from the agricultural sector in the EU-25

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May 2006

Abstract

This report presents three emission scenarios of non-CO_2 greenhouse gases from the agricultural sector of the EU-25 until 2020. These scenarios explore the likely implications of changes in agricultural production due to the

- implementations of the EU Agenda 2000 CAP Reform of 1999 and the EU Nitrates Directive of 1991 (as used for the analyses of the EU Clean Air for Europe (CAFE) programme),
- the implementation of the 2003 Mid-term review of the CAP reform and from anticipated impacts on fertilizer use of the reform of the EU sugar sector agreed in 2005,
- and compare them with the agricultural projections provided by the EU Member States to IIASA for the preparations of the revision of the EU Emission Ceilings Directive in 2005.

The emission scenarios have been developed with IIASA's Greenhouse and Air pollution Interactions and Synergies (GAINS) model (www.iiasa.ac.at/gains), which constitutes an extension of the Regional Air Pollution Information and Simulation (RAINS) model (www.iiasa.ac.at/rains) to greenhouse gases.

All scenarios suggest for the EU-25 a significant decline of agricultural non-CO_2 greenhouse gas emissions between 1990 and future years, mainly as a consequence of declining cattle numbers due to productivity increases in milk and beef production and more efficient application of fertilizers.

For the first scenario (i.e., CAFE projections reflecting the impacts of the Agenda 2000 CAP reform and the Nitrates Directive), an 11-13 percent decline of emissions from the EU-25 is estimated for the period 1990 to 2010, depending on the calculation methodology. The changes in livestock numbers and fertilizer use implied by the 2003 Mid-term review of the CAP reform and the EU sugar reform would reduce non-CO_2 greenhouse gas emissions further by approximately four percentage points. Based on the national projections of livestock numbers and fertilizer use as provided in 2005 by the Member States for the NEC revision, agricultural non-CO_2 greenhouse gases are computed to decline by approximately 16 percent up to 2010.

These trends show significant variations across Member States. Emissions from the old Member States (EU-15) are calculated to decline by between 7 to 13 percent, depending on the agricultural scenario and calculation method. For the new Member States (NMS-10), reductions between 32 and 35 percent are estimated.

More than half of these reductions have occurred between 1990 and 1995, mainly due to the structural changes in the New Member States. Scenario 1 results in four percent additional emission reductions between 1995 and 2010, while the Mid-term CAP review Scenario 2 and the national projections suggest an eight percent further decline between 1995 and 2010. Beyond 2010, both projections indicate a further decline by approximately two percentage points.

Acknowledgements

The author gratefully acknowledges the financial support for their work received from the European Commission, DG-ENV.

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1 Introduction

Agricultural activities constitute an important source of greenhouse gas emissions, and they could offer a cost-effective potential for further reducing greenhouse gas emissions. In addition to specific technical mitigation measures, changes in livestock numbers and fertilizer use are main factors that determine future emissions of greenhouse gases from agricultural sources.

This report explores for three scenarios of agricultural activities in the EU Member States the resulting emissions of methane (CH_4) and nitrous oxides (N_2O) up to the year 2020. These activity projections that have been provided by different sources reflect different assumptions on agricultural development and policy interactions and constitute an exogenous input to the emission calculations.

In particular, this report examines the likely implications on emissions from changes in agricultural production due to

- the implementations of the EU Agenda 2000 CAP Reform of 1999 and the EU Nitrates Directive of 1991 as used for the analyses of the EU Clean Air for Europe (CAFE) programme,
- the implementation of the 2003 Mid-term review of the CAP reform and from anticipated impacts on fertilizer use of the reform of the EU sugar sector agreed in 2005,
- and compares them with the agricultural projections provided by the EU Member States to IIASA in the course of the preparations for the revision of the EU Emission Ceilings Directive in 2005.

The emission scenarios have been developed with IIASA's Greenhouse and Air pollution Interactions and Synergies (GAINS) model (www.iiasa.ac.at/gains), which constitutes an extension of the Regional Air Pollution Information and Simulation (RAINS) model (www.iiasa.ac.at/rains) to greenhouse gases. The GAINS 1.0 model is documented for methane in Höglund-Isaksson and Mechler (2004) and for nitrous oxide in Winiwarter (2005).

The remainder of this report is organized as follows: Section 2 summarizes the methodology used for the emission calculation. Section 3 presents the key driving factors for the emissions of non-CO_2 greenhouse gases in the agricultural sector. Section 4 presents the resulting emission projections, and Section 5 draws the conclusions from the analysis. Detailed model results are available in electronic supporting material.

This report has been prepared as a background document for the meeting of the Topic Group Agriculture and Forestry under the ECCP-I review of the European Climate Change Programme of the European Commission on January 31, 2006.

2 Methodology

2.1 Computation of emissions

The Greenhouse gas and Air pollution Interactions and Synergies (GAINS) model has been developed to assess future emissions of greenhouse gases and conventional air pollutants and to identify cost-effective potentials for reducing both types of emissions. The model produces emission scenarios for any exogenously supplied projection of future economic activities. It estimates technical potentials for emission controls, the costs of such measures and interactions in abatement between various pollutants (Klaassen *et al.*, 2004). The GAINS methodology follows the standard RAINS methodology (http://www.iiasa.ac.at/rains) that has been developed for the construction of emission scenarios for conventional air pollutants and applied, inter alia, for the analyses of the Clean Air For Europe (CAFE) programme.

Emissions of each pollutant p are calculated as the product of the activity levels, the "uncontrolled" emission factor in absence of any emission control measures, the efficiency of emission control measures and the application rate of such measures:

$$E_{i,p} = \sum_{j,a,t} E_{i,j,a,t,p} = \sum_{j,a,t} A_{i,j,a} ef_{i,j,a,p} \left(1 - eff_{t,p}\right) X_{i,j,a,t} \quad \text{Equation 2.1}$$

where

i,j,a,t,p	Country, sector, activity, abatement technology, pollutant
$E_{i,p}$	Emissions of the specific pollutant p in country i
A	Activity in a given sector
ef	"Uncontrolled" emission factor
eff	Reduction efficiency
X	Actual implementation rate of the considered abatement.

For anthropogenic emissions of methane and nitrous oxide from the agricultural sector, enteric fermentation in animal rumens, manure management, and soils constitute the major sources in the European Union. Rice cultivation, while of significance at the global scale, is a minor source in Europe.

Emissions are calculated for each sector and country, based on country-, sector- and technology-specific data. Data for individual countries are accessible from the on-line version of the RAINS and GAINS models on the Internet (www.iiasa.ac.at/rains).

This report examines the implications on emissions from three alternative, exogenously supplied projections of activity data. Projections of future activity data have been provided by the CAPRI and CAPSIM agricultural models as well as by Member States in the course of the bilateral consultations on the RAINS databases for the review of the National Emission Ceilings Directive in 2005.

The resulting emission estimates are reported in this paper in CO_2eq., using Global Warming Potentials for CH_4 of 21 and for N_2O of 310.

2.2 Use of uniform or country-specific emission factors

For the reports of national emission estimates to the European Commission and the UNFCCC, Member States are allowed to use emission factors based on results from national studies instead of the default emission factors presented by the Intergovernmental Panel on Climate Change (IPCC) (Houghton *et al.*, 1997). The possibility of using national estimates of emission factors should render more accurate estimates and provide an incentive for countries to undertake local studies and thereby contribute to a broadening of the general knowledge base of emission factors. It turns out, however, that differences between emission factors for the same source category used by individual countries are sometimes large, and it is not always obvious how such large differences can be explained. This constitutes a serious impediment for cross-country comparisons.

For sake of international consistency, the standard approach of the GAINS model uses IPCC default emission factors as a principal basis for all countries, and considers country-specific modifications based on objective and documented factors. For most agricultural sectors, GAINS applies IPCC default emission factors (Houghton et al., 1997). An exception is manure management, where the IPCC default emission factors are modified to reflect counry-specific differences between liquid and solid manure management (Brink, 2003). Thereby, GAINS estimates achieve international comparability, however at the expenses of deviations from national estimates.

Table 2.1 compares for some important source categories the emission factors currently used by the GAINS model with emission factors used by individual countries for their reports to the European Commission and the UNFCCC. Largest discrepancies occur for Western European countries with cold climate according to the IPCC definition (Houghton et al., 1997, p.4.8) and amount in some cases up to a factor of six. Unfortunately, the basis for such large differences is not always documented in a transparent way. Further work will be necessary to develop a common methodology that reflects the large differences emerging from measurements in different countries.

Table 2.1: Comparison of emission factors for methane from enteric fermentation and manure management in year 2000 for a selection of Western European countries with cool climate [kg CH_4/head/year].

Source	Animal category	GAINS emission factor	IPCC default (Houghton et al., 1997)	Belgium NIR to UNFCCC (2005)	France NIR to UNFCCC (2005)	Germany NIR to UNFCCC (2005)	Sweden NIR to UNFCCC (2005)	Denmark NIR to UNFCCC (2005)
Enteric fermen-tation	Dairy cows	100	100	104.4	102.87	101.9	125.41	117.23
	Non-dairy cattle	48	48	48	51.77	73.2	56.38	35.64
	Sheep	8	8	6.9	8	8	8	17.17
	Goat	8	5	9.4	5	n.a.	5	13.15
	Horses	18	18	18.4	18	18	18	23.9
	Pigs	1.5	1.5	1.1	1.5	2.04	1.61	1.11
	Poultry	0	0	0	0	0	0	0
Manure manage-ment	Dairy cows	Liquid: 29.9 Solid: 3.0	14	21.1	18.4	85.4	15.49	16.06
	Non-dairy cattle	Liquid: 11.2 Solid: 1.1	6	13.9	18.5	19.7	4.24	1.68
	Sheep	0.19	0.19	1.44	0.28	0.19	0.19	0.32
	Goat	0.19	0.12	1.25	0.18	n.a.	0.12	0.26
	Horses	1.4	1.39	27.0	2.11	2.71	1.4	1.74
	Pigs	Liquid: 5.5 Solid: 0.6	3	9.76	20.9	27.0	2.64	2.66
	Poultry	0.078	0.078	0.148	0.12	0.078	0.08	0.01

These differences in emission factors obviously have impacts on the ability of the GAINS model to fully reproduce nationally reported emission data. Table 2.2 compares the GAINS methane emission estimates from the agricultural sector for the year 2000 with the emission figures reported by Member States to the European Commission (EEA, 2005) and to UNFCCC (2005). In some cases GAINS calculations deviate by up to 76 percent from the national MS estimates because of differences in emission factors.

As mentioned above, recalculations of national emission factors also affect historic base year inventories, which are used as a starting point for temporal comparisons. This is illustrated by Table 2.2, which, in addition to national estimates reported in the year 2005, also presents national estimates reported in the year 2001 to UNFCCC (UNFCCC, 2001). It is evident that for some countries, emission estimates reported in 2005 deviate substantially from the estimates reported four years earlier, which complicates a consistent evaluation of emission trends.

Table 2.2: Methane emission estimates for the year 2000 for the agricultural sector as resulting from the GAINS model and as reported by the EU member states to the European Commission and the UNFCCC.

Country	Total agriculture GAINS estimates for the year 2000	Total agricultural emissions 2000 reported in 2005 (EEA, 2005; National Inventory Submissions 2005 UNFCCC, 2005)		Total agricultural emissions 2000 reported in 2001 (3rd National Communication UNFCCC, 2001)	
	[kt CH_4/year]	[kt CH_4/ yr]	Difference to GAINS estimate	[kt CH_4/ yr]	Difference to GAINS estimate
Austria	175	198	-13 %	188	-7 %
Belgium	253	334	-32 %	330	-30 %
Cyprus	18	15	+16 %	n.a.	n.a.
Czech Rep.	146	116	+21 %	121	+17 %
Denmark	222	181	+18 %	170	+23 %
Estonia	22	24	-11 %	26	-18 %
Finland	85	86	-1 %	84	+1 %
France	1460	2063	-41 %	1535	-5 %
Germany	1330	2342	-76 %	1469	-10 %
Greece	200	174	+13 %	170	+15 %
Hungary	107	110	-3 %	116	-8 %
Ireland	490	540	-10 %	541	-10 %
Italy	1029	847	+18 %	n.a.	n.a.
Latvia	30	36	-18 %	31	-3 %
Lithuania	79	72	+10 %	n.a.	n.a.
Luxembourg	15	17	-15 %	n.a.	n.a.
Malta	4	4	-11 %	n.a.	n.a.
Netherlands	460	434	+6 %	423	+8 %
Poland	464	470	-1 %	509	-10 %
Portugal	181	218	-20 %	280	-55 %
Slovak Rep.	61	62	-2 %	64	-5 %
Slovenia	41	42	-4 %	41	0 %
Spain	1002	1098	-10 %	1040	-4 %
Sweden	138	157	-14 %	161	-17 %
UK	985	956	+3 %	1002	-2 %

To facilitate comparability across countries and across time, this report presents emission scenarios using two different methods: It presents the GAINS calculations based on the GAINS emission factors, and compares them with “adjusted” estimates that take into account differences in nationally used emission factors. These adjusted estimates scale, on a sectoral basis, the GAINS estimates for a future year by the difference between the GAINS 2000 sectoral estimate and the nationally reported figure for the year 2000, as submitted by Member States to the European Commission (EEA, 2005) and the UNFCCC (2005).

3 Projections of agricultural activities

Animal numbers and fertilizer use constitute the major anthropogenic driving forces of greenhouse gas emissions from the agricultural sector. The GAINS model does not internally compute the future evolution of these activities, but takes historic statistics and future projections as an exogenous input from other sources and calculates the resulting implications on greenhouse gas emissions and mitigation potentials.

This report examines future methane and nitrous oxides emissions for three different sets of exogenous projections of agricultural activities, but does not address potential technical mitigation measures that could influence emissions. In particular, this report examines the likely implications on emissions from changes in agricultural production due to

- the implementations of the EU Agenda 2000 CAP reform of 1999 and the EU Nitrates Directive of 1991 as used for the analyses of the EU Clean Air for Europe (CAFE) programme,
- the implementation of the 2003 Mid-term review of the CAP reform and from anticipated impacts on fertilizer use of the reform of the EU sugar sector agreed in 2005,
- and compares them with the agricultural projections provided in 2005 by the EU Member States to IIASA in the course of the bilateral consultations for the revision of the EU Emission Ceilings Directive.

3.1 Scenario 1: Effects of the Agenda 2000 CAP Reform and the Nitrates Directive

The first scenario calculates changes in greenhouse gas emissions that can be associated with the development of the agricultural sector as a consequence of the Agenda 2000 CAP reform (EC, 1999) and the Nitrate Directive adopted by the EC in December 1991 (EC, 1991).

The Agenda 2000 CAP reform is expected to have affected animal numbers through, e.g., reduced guaranteed prices for beef and veal as well as through production limits on milk. Animal numbers are also indirectly affected by the direct payments to farmers and the strengthened requirements to regard good farming practices and environmental concerns. The Nitrates Directive aims at reducing nitrate leaching to water and implies reduced use of fertilizer through an encouragement of more efficient applications of fertilizer.

For the projection up to 2010, livestock data have been derived from CAPRI model scenarios conducted by the University of Bonn (EC, 2002a). Beyond 2010, the scenario relies on FAO projections FAO (Bruinsma, 2003). Projections of fertilizer use originate up to 2010 from the European Fertilizer Manufacturers Association (EFMA, 2003), and from FAO thereafter (Bruinsma, 2003). Key activity data for this scenario are presented for the EU-25, EU-15 and NMS-10, respectively in Table 3.1 to Table 3.3 and by country in the Appendix A1.

Animal numbers and fertilizer use are identical to those used for the RAINS calculations of the baseline and policy scenarios of the Clean Air For Europe (CAFE) programme in 2004/2005 (all reports and data are available at www.iiasa.ac.at/rains/cafe.html).

Table 3.1: EU-25: Key driving factors for emissions of methane and nitrous oxide from the agricultural sector for Scenario 1 taking account of the impacts of the Nitrates Directive and the Agenda 2000 CAP reform

Activity	Unit	Year						
		1990	1995	2000	2005	2010	2015	2020
Dairy cows	M heads	34.7	28.9	25.3	24.4	22.7	22.7	22.2
Non-dairy cattle	M heads	75.9	71.1	66.9	66.7	66.3	62.5	59.3
Pigs	M heads	160.5	149.4	151.8	165.0	170.7	171.7	171.6
Sheep	M heads	118.4	106.1	108.4	110.5	109.5	108.7	104.8
Horses	M heads	4.2	3.9	3.9	3.8	3.9	3.9	3.9
Laying hens	M heads	468.8	430.2	419.3	438.5	449.8	450.9	449.3
Poultry	M heads	811.3	847.0	900.5	967.5	998.5	1017.6	1042.8
Rice area harvested	M ha	368.0	368.0	368.0	368.0	368.0	368.0	368.0
Fertilizer use	Mt N	12.2	11.0	11.1	11.0	10.9	10.9	10.8

Table 3.2: EU-15: Key driving factors for emissions of methane and nitrous oxide from the agricultural sector for Scenario 1 taking account of the impacts of the Nitrates Directive and the Agenda 2000 CAP reform

Activity	Unit	Year						
		1990	1995	2000	2005	2010	2015	2020
Dairy cows	M heads	26.1	22.5	20.1	19.4	18.1	18.1	17.7
Non-dairy cattle	M heads	63.9	63.8	61.2	61.2	61.0	57.5	54.3
Pigs	M heads	117.2	117.0	123.8	133.7	138.3	139.2	139.1
Sheep	M heads	111.3	103.1	105.5	107.4	106.4	105.5	101.6
Horses	M heads	3.0	3.1	3.1	3.2	3.4	3.4	3.4
Laying hens	M heads	359.7	345.9	338.9	357.2	367.6	367.7	365.9
Poultry	M heads	688.4	772.7	834.6	871.3	902.2	915.2	933.9
Rice area harvested	M ha	357.0	357.0	357.0	357.0	357.0	357.0	357.0
Fertilizer use	Mt N	10.2	9.5	9.3	9.0	8.9	8.8	8.6

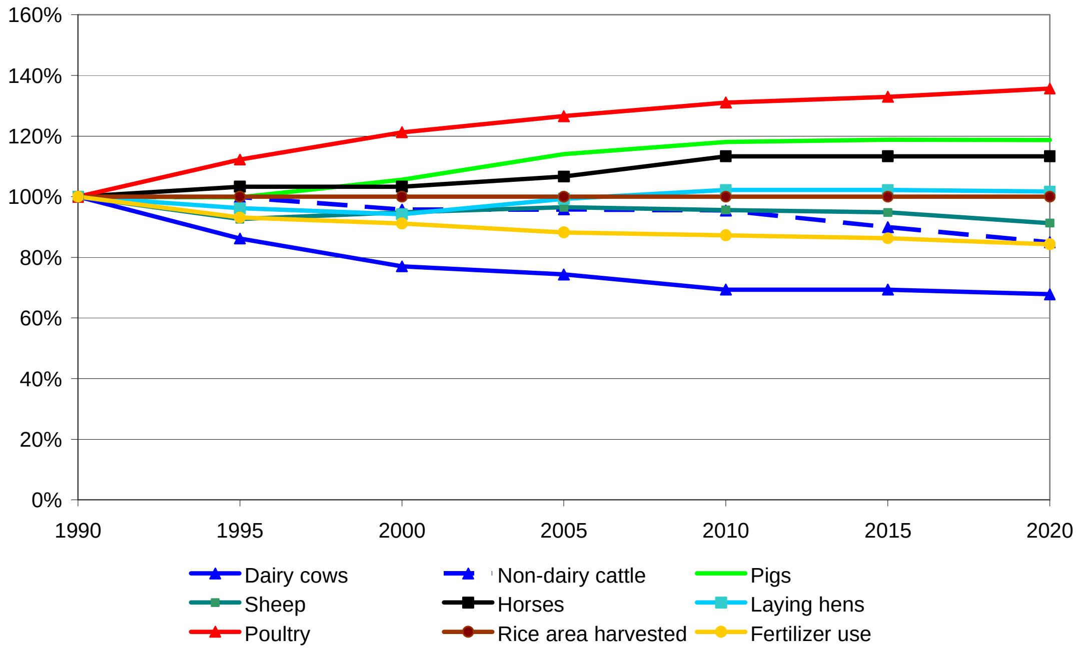

Figure 3.1: Temporal development of key driving factors for emissions of methane and nitrous oxide from the agricultural sector of the EU-15 for Scenario 1 taking account of the impacts of the Nitrates Directive and the Agenda 2000 CAP reform (scaled to 1990)

Table 3.3: NMS-10: Key driving factors for emissions of methane and nitrous oxide from the agricultural sector for Scenario 1 taking account of the impacts of the Nitrates Directive and the Agenda 2000 CAP reform

Activity	Unit	Year						
		1990	1995	2000	2005	2010	2015	2020
Dairy cows	M heads	8.6	6.4	5.2	4.9	4.6	4.6	4.5
Non-dairy cattle	M heads	12.0	7.3	5.7	5.6	5.3	5.1	4.9
Pigs	M heads	43.3	32.4	28.1	31.2	32.4	32.5	32.5
Sheep	M heads	7.1	3.0	2.9	3.0	3.1	3.2	3.2
Horses	M heads	1.2	0.8	0.8	0.6	0.6	0.6	0.6
Laying hens	M heads	109.2	84.3	80.3	81.3	82.2	83.2	83.4
Poultry	M heads	122.9	74.3	65.9	96.3	96.3	102.4	108.8
Rice area harvested	M ha	11.0	11.0	11.0	11.0	11.0	11.0	11.0
Fertilizer use	Mt N	2.0	1.5	1.8	1.9	2.0	2.1	2.2

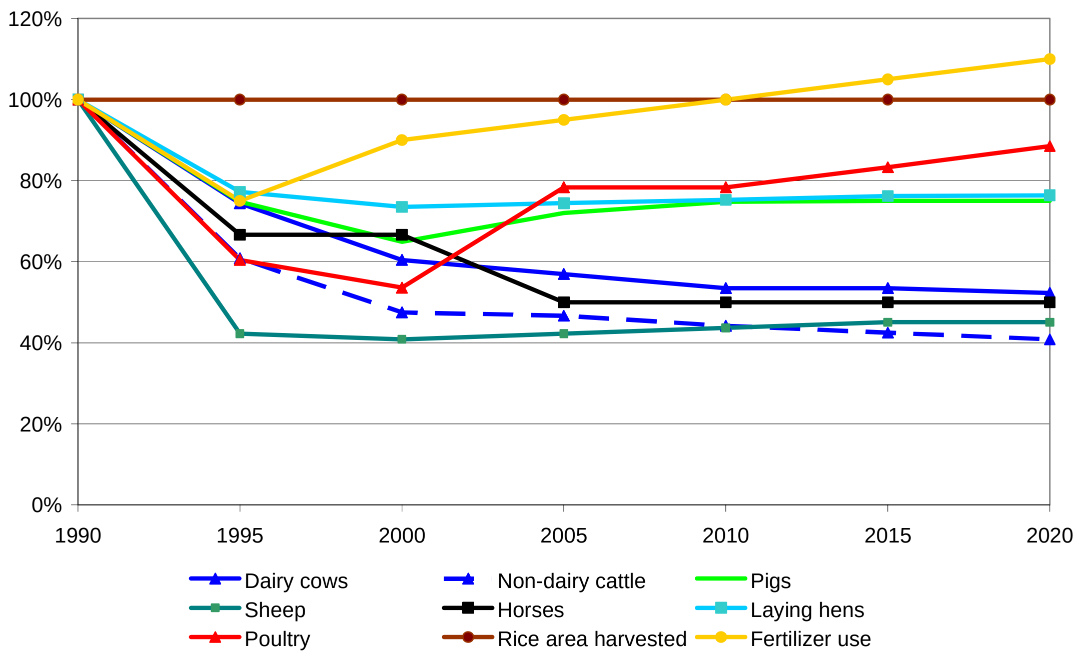

Figure 3.2: Temporal development of key driving factors for emissions of methane and nitrous oxide from the agricultural sector of the 10 new Member States for Scenario 1 taking account of the impacts of the Nitrates Directive and the Agenda 2000 CAP reform (scaled to 1990)

3.2 Scenario 2: Effects of the Mid-term review CAP reform

The second scenario examines the potential implications of recent changes in EU agricultural policy.

The Mid-term review of the CAP reform (EC, 2002b) adopted by the EC in June 2003 (http://europa.eu.int/comm/agriculture/capreform) implies a decoupling of most direct aid payments from agricultural production. Instead, aid payments are linked to environmental targets in order to promote a sustainable agricultural production. The expected effects include a more extensive agricultural production, better fulfilment of environmental standards and improved food safety and animal health.

The reform of the EU sugar sector was agreed on by the EU in November 2005 (http://europa.eu.int/comm/agriculture/capreform/sugar/index_en.htm) and implies a decoupling of the direct payments from production. As a result, sugar prices are expected to fall while production and import of sugar from third world countries is expected to increase.

Animal numbers used for this scenario were adopted from projections produced by the CAPSIM agricultural simulation model (EuroCARE, 2004). For animal categories with a turnover rate faster than one year, i.e., pigs, poultry and sheep, the total animal numbers (slaughtered animals) generated by the CAPSIM model had to be converted into figures on alive animals at a given time, which is the emission-relevant variable. This conversion applied the annual average growth rates from the CAPSIM model to the animal numbers of the year 2000. Projections of fertilizer use were provided by the European Fertilizer Manufacturers Association (EFMA, 2005) and are assumed to take into account the effects on fertilizer use from the Mid-term review CAP reform and the anticipated impacts of the reform of the EU sugar sector.

Key driving factors for methane and nitrous oxide emissions for Scenario 2 are presented in Table 3.4 to Table 3.6.

Table 3.4: EU-25: Key driving factors for emissions of methane and nitrous oxide from the agricultural sector taking account of effects of the Mid-term review CAP reform.

Activity	Unit	Year						
		1990	1995	2000	2005	2010	2015	2020
Dairy cows	M heads	34.7	28.9	25.3	23.8	22.2	21.0	20.0
Non-dairy cattle	M heads	75.9	71.1	66.9	64.5	62.3	62.4	62.7
Pigs	M heads	160.5	149.4	151.8	156.0	160.2	162.3	162.3
Sheep	M heads	118.4	106.1	108.4	102.7	99.2	101.8	100.6
Horses	M heads	4.2	3.9	3.9	3.8	3.9	3.9	3.9
Laying hens	M heads	468.8	430.2	419.3	394.0	368.8	354.8	341.0
Poultry	M heads	811.3	847.0	900.5	927.0	952.4	997.7	1042.2
Rice area harvested	M ha	368.0	368.0	368.0	368.0	368.0	368.0	368.0
Fertilizer use	Mt N	12.2	11.0	10.9	10.5	10.4	10.3	10.2

Table 3.5: EU-15: Key driving factors for emissions of methane and nitrous oxide from the agricultural sector taking account of effects of the Mid-term review CAP reform.

Activity	Unit	Year						
		1990	1995	2000	2005	2010	2015	2020
Dairy cows	M heads	26.1	22.5	20.1	19.1	17.9	16.9	16.0
Non-dairy cattle	M heads	63.9	63.8	61.2	59.0	57.0	57.0	57.1
Pigs	M heads	117.2	117.0	123.8	126.2	128.5	129.6	128.9
Sheep	M heads	111.3	103.1	105.5	99.7	96.2	98.6	97.2
Horses	M heads	3.0	3.1	3.1	3.2	3.4	3.4	3.4
Laying hens	M heads	359.7	345.9	338.9	319.3	299.6	289.1	278.7
Poultry	M heads	688.4	772.7	834.6	848.1	861.7	897.9	934.5
Rice area harvested	M ha	357.0	357.0	357.0	357.0	357.0	357.0	357.0
Fertilizer use	Mt N	10.1	9.4	9.2	8.6	8.4	8.3	8.1

Table 3.6: NMS-10: Key driving factors for emissions of methane and nitrous oxide from the agricultural sector taking account of effects of the Mid-term review CAP reform.

Activity	Unit	Year						
		1990	1995	2000	2005	2010	2015	2020
Dairy cows	M heads	8.6	6.4	5.2	4.7	4.3	4.1	4.0
Non-dairy cattle	M heads	12.0	7.3	5.7	5.5	5.3	5.4	5.6
Pigs	M heads	43.3	32.4	28.1	29.9	31.6	32.7	33.4
Sheep	M heads	7.1	3.0	2.9	3.0	3.0	3.2	3.4
Horses	M heads	1.2	0.8	0.8	0.6	0.6	0.6	0.6
Laying hens	M heads	109.2	84.3	80.3	74.8	69.2	65.7	62.3
Poultry	M heads	122.9	74.3	65.9	78.9	90.8	99.8	107.6
Rice area harvested	M ha	11.0	11.0	11.0	11.0	11.0	11.0	11.0
Fertilizer use	Mt N	2.0	1.5	1.7	1.9	2.0	2.1	2.2

3.3 Scenario 3: National projections

For the revision of the EU Directive on National Emission Ceilings, IIASA conducted in 2005 a series of bilateral consultations with designated experts from most EU Member States and industrial stakeholders to review input data of the RAINS model (www.iiasa.ac.at/rains/CAFE_files/timetable_NECD_JC.html). During these consultations, 16 out of the 25 Member States provided national projections of agricultural activities including animal numbers and fertilizer use. Projections have been received from all Member States with the exceptions of Belgium, Cyprus, Germany, Greece, Lithuania, Luxembourg, Malta, Slovak Republic and Spain.

Scenario 3 assumes the development of agricultural according to these national projections. For the nine countries that have not supplied projections, activity projections of Scenario 2 have been assumed. Key driving factors for methane and nitrous oxide emissions from the agricultural sector of Scenario 3 are presented in Tables Table 3.7 to Table 3.9.

Table 3.7: EU-25: Key driving factors for emissions of methane and nitrous oxide from the agricultural sector provided by Member States during the bilateral consultations with IIASA on the RAINS input data for the revision of the National Ceilings Directive in 2005. For countries who have not supplied national projections to IIASA the numbers of Scenario 2 were used.

Activity	Unit	Year						
		1990	1995	2000	2005	2010	2015	2020
Dairy cows	M heads	34.9	28.8	25.5	23.7	22.1	21.3	20.9
Non-dairy cattle	M heads	76.0	71.0	67.5	64.1	62.3	61.2	61.1
Pigs	M heads	161.6	149.5	151.2	152.8	155.1	157.8	159.2
Sheep	M heads	121.1	109.1	111.4	104.7	102.5	103.6	104.7
Horses	M heads	4.1	3.9	4.0	3.9	4.0	4.1	4.1
Laying hens	M heads	473.5	428.5	416.4	403.4	390.8	382.6	378.3
Poultry	M heads	851.2	851.0	941.1	1021.7	1028.8	1058.3	1040.5
Rice area harvested	M ha	368.0	368.0	368.0	368.0	368.0	368.0	368.0
Fertilizer use	Mt N	12.4	10.9	11.4	10.8	10.8	10.7	10.7

Table 3.8: EU-15: Key driving factors for emissions of methane and nitrous oxide from the agricultural sector provided by Member States during the bilateral consultations with IIASA on the RAINS input data for the revision of the National Ceilings Directive in 2005. For countries who have not supplied national projections to IIASA the numbers of Scenario 2 were used.

Activity	Unit	Year						
		1990	1995	2000	2005	2010	2015	2020
Dairy cows	M heads	26.3	22.4	20.3	19.0	17.7	17.1	16.8
Non-dairy cattle	M heads	63.9	63.7	61.9	58.8	56.7	55.5	55.4
Pigs	M heads	118.4	117.1	123.4	125.3	125.6	127.3	127.6
Sheep	M heads	113.9	106.1	108.5	101.5	99.2	100.2	101.2
Horses	M heads	2.9	3.1	3.2	3.3	3.5	3.5	3.5
Laying hens	M heads	365.5	341.6	336.2	324.9	313.3	305.9	302.4
Poultry	M heads	656.2	772.7	812.5	818.3	817.9	843.2	822.2
Rice area harvested	M ha	357.0	357.0	357.0	357.0	357.0	357.0	357.0
Fertilizer use	Mt N	10.3	9.4	9.7	9.0	8.9	8.8	8.7

Table 3.9: NMS-10: Key driving factors for emissions of methane and nitrous oxide from the agricultural sector provided by Member States during the bilateral consultations with IIASA on the RAINS input data for the revision of the National Ceilings Directive in 2005. For countries who have not supplied national projections to IIASA the numbers of Scenario 2 were used.

Activity	Unit	Year						
		1990	1995	2000	2005	2010	2015	2020
Dairy cows	M heads	8.6	6.4	5.2	4.7	4.4	4.2	4.1
Non-dairy cattle	M heads	12.1	7.3	5.7	5.4	5.6	5.6	5.7
Pigs	M heads	43.1	32.4	27.8	27.5	29.5	30.5	31.7
Sheep	M heads	7.2	3.0	3.0	3.2	3.3	3.4	3.5
Horses	M heads	1.2	0.8	0.8	0.6	0.6	0.6	0.6
Laying hens	M heads	108.1	87.0	80.2	78.5	77.5	76.8	75.9
Poultry	M heads	195.0	129.6	128.5	203.4	211.0	215.1	218.3
Rice area harvested	M ha	11.0	11.0	11.0	11.0	11.0	11.0	11.0
Fertilizer use	Mt N	2.0	1.5	1.7	1.8	1.8	1.9	1.9

4 Results

4.1 Emission changes by pollutants

4.1.1 Methane emissions

Based on the activity projections of the Agenda 2000 CAP reform, agricultural methane emissions of the EU-25 are expected to drop by 12 to 16 percent between 1990 and 2010, depending on the calculation methodology (Table 4.1). Some further reductions are expected beyond 2010 (Table 4.2). For the implementation of the Mid-term review CAP reform (Scenarios 2 and 3), methane emissions from the agricultural sector in EU-25 are calculated to fall by at least 17 percent between 1990 and 2010. Larger reductions are expected for the 10 new Member States (between 45 and 53 percent), while emissions from the 15 old Member States should decline between 10 and 15 percent.

Table 4.1: Changes in methane emissions from the agricultural sector between 1990 and 2010 for the three scenarios

		Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3
EU-25	GAINS methodology	-16.3 %	-19.9 %	-19.7 %
	Adjusted GAINS estimates	-12.7 %	-17.1 %	-17.9 %
EU-15	GAINS methodology	-9.3 %	-13.7 %	-14.5 %
	Adjusted GAINS estimates	-6.1 %	-10.7 %	-12.1 %
NMS-10	GAINS methodology	-48.6 %	-48.6 %	-45.9 %
	Adjusted GAINS estimates	-50.0 %	-52.6 %	-50.0 %

Table 4.2: Changes in methane emissions from the agricultural sector between 1990 and 2015 for the three scenarios

		Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3
EU-25	GAINS methodology	-18.1 %	-20.8 %	-20.6 %
	Adjusted GAINS estimates	-14.7 %	-18.3 %	-19.0 %
EU-15	GAINS methodology	-11.5 %	-14.8 %	-15.6 %
	Adjusted GAINS estimates	-7.9 %	-12.1 %	-13.6 %
NMS-10	GAINS methodology	-48.6 %	-48.6 %	-45.9 %
	Adjusted GAINS estimates	-52.6 %	-52.6 %	-50.0 %

These emission reductions in methane emissions result primarily from falling cattle numbers, which imply less enteric fermentation and manure generation. Cattle numbers decline partly due to the Agenda 2000 CAP reform, which is expected to lead to 20 percent less dairy cows and non-dairy cattle, and partly due to autonomous productivity increases coupled with demand limits on milk and beef (Scenario 1). The implementation of the Mid-term review CAP reform of 2003 is expected to further reduce cattle numbers by about four percent (Scenarios 2 and 3). The national agricultural projections, to the extent they are available (Scenario 3), project in general slightly higher livestock reductions than the CAPRI model.

4.1.2 Nitrous oxide emissions

Based on the activity projections for the Agenda 2000 CAP reform, agricultural N_2O emissions of the EU-25 are expected to drop by approximately 10 percent between 1990 and 2010 (Table 4.3). Some further reductions are expected beyond 2010 (Table 4.4). For the implementation of the Mid-term review CAP reform (Scenarios 2 and 3), N_2O emissions from the agricultural sector in the EU-25 are calculated to fall by about 13-14 percent between 1990 and 2010. Larger reductions are expected for the 10 new Member States (20-23 percent), while emissions from the 15 old Member States should decline less.

The decline in nitrous oxide emissions is primarily linked to the lower consumption of fertilizer (about 10 percent between 1990 and 2010) due to the expected improvements in the efficiency of fertilizer application, inter alia as a consequence of the Agenda 2000 reform (Scenario 1). The implementation of the Mid-term review CAP reform (Scenarios 2 and 3) is expected to reduce fertilizer use by another 3 to 4 percent in 2010.

Table 4.3: Changes in nitrous oxide emissions from the agricultural sector between 1990 and 2010 for the three scenarios

		Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3
EU-25	GAINS methodology	-10.0 %	-13.7 %	-13.9 %
	Adjusted GAINS estimates	-9.5 %	-12.9 %	-13.6 %
EU-15	GAINS methodology	-8.1 %	-12.2 %	-11.3 %
	Adjusted GAINS estimates	-7.7 %	-11.7 %	-12.1 %
NMS-10	GAINS methodology	-18.9 %	-22.6 %	-23.3 %
	Adjusted GAINS estimates	-19.1 %	-19.1 %	-21.3 %

Table 4.4: Changes in nitrous oxide emissions from the agricultural sector between 1990 and 2015 for the three scenarios

		Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3
EU-25	GAINS methodology	-11.0 %	-14.0 %	-14.6 %
	Adjusted GAINS estimates	-10.2 %	-13.2 %	-14.2 %
EU-15	GAINS methodology	-9.3 %	-13.0 %	-12.1 %
	Adjusted GAINS estimates	-8.9 %	-12.5 %	-12.9 %
NMS-10	GAINS methodology	-17.0 %	-20.8 %	-23.3 %
	Adjusted GAINS estimates	-17.0 %	-17.0 %	-19.1 %

4.1.3 Total non-CO_2 greenhouse gases

The autonomous productivity and efficiency increases and the implementations of agricultural reform policies as well as the Nitrates Directive will lead to lower overall non-CO_2 greenhouse gas emissions from the agricultural sector in the EU-25. On a CO_2–equivalent basis, the methane and N_2O reductions will lower overall GHG emissions from this sector by 11 to 13 percent between 1990 and 2010 (Table 4.5). The Mid-term review CAP reform, also as reflected by national projections (Scenarios 2 and 3), are expected to further reduce agricultural GHG emissions by about four percent, leading to a total reduction in 2010 of about 15 to 17 percent. Approximately 45 percent of this decline is linked to lower emissions of methane, while changes in nitrous oxides emissions make up the residual 55 percent.

Table 4.5: Changes in non-CO_2 greenhouse gas emissions from the agricultural sector between 1990 and 2010 for the three scenarios

		Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3
EU-25	GAINS methodology	-12.7 %	-16.5 %	-16.4 %
	Adjusted GAINS estimates	-11.0 %	-14.8 %	-15.5 %
EU-15	GAINS methodology	-8.6 %	-12.6 %	-12.7 %
	Adjusted GAINS estimates	-6.9 %	-11.3 %	-12.1 %
NMS-10	GAINS methodology	-31.9 %	-34.1 %	-32.7 %
	Adjusted GAINS estimates	-32.9 %	-34.1 %	-34.1 %

Table 4.6: Changes in non-CO_2 greenhouse gas emissions from the agricultural sector between 1990 and 2015 for the three scenarios

		Scenario 1	Scenario 2	Scenario 3
EU-25	GAINS methodology	-14.0 %	-17.1 %	-17.1 %
	Adjusted GAINS estimates	-12.2 %	-15.4 %	-16.5 %
EU-15	GAINS methodology	-10.2 %	-13.5 %	-13.6 %
	Adjusted GAINS estimates	-8.4 %	-12.3 %	-13.2 %
NMS-10	GAINS methodology	-31.9 %	-33.0 %	-32.7 %
	Adjusted GAINS estimates	-32.9 %	-32.9 %	-34.1 %

It is noteworthy to point out that more than half of the expected declines in emissions have already materialized between 1990 and 1995 as a consequence of the structural economic changes. This holds not only for the New Member States, for which the decline was caused by the economic transitions in the early 1990s, but also for the old EU-15 countries, for which at least one third of the total projected reduction between 1990 to 2010 has been recorded during the first five years.

4.2 Emission changes by sector

4.2.1 Scenario 1: Implementation of the Agenda 2000 CAP reform and Nitrates Directive

The most important sources for emissions of non-CO_2 greenhouse gases from the agricultural sector are enteric fermentation and soils. Methane emissions from enteric fermentation make up about 30 percent and nitrous oxide emissions from soils make up about 50 percent of total non-CO_2 greenhouse gases from agriculture. These are also the principal sources for projected emission reductions. Productivity increases in milk and beef production coupled with demand limits imply falling numbers of dairy cows and cattle. As a consequence, methane emissions from enteric fermentation are projected to fall by 17 to 21 percent between 1990 and 2010 in EU-25, with reductions of 10 to 14 percent in EU-15 countries only. Improved efficiency in fertilizer application on soils, partly induced by the Agenda 2000 CAP reform and the Nitrates Directive, are projected to reduce nitrous oxide emissions from this source by 9 to 11 percent in EU-25, with a corresponding reduction of about seven percent in EU-15.

Table 4.7: GAINS emission estimates for CH_4 and N_2O for the implementation of Agenda 2000 CAP Reform and the Nitrates Directive for the EU-25, using uniform emission factors [Mt CO_2 equivalent]

Gas		Year						
		1990	1995	2000	2005	2010	2015	2020
CH4	Agriculture	**221**	**199**	**189**	**189**	**185**	**181**	**176**
	Enteric fermentation	175	155	144	143	139	135	130
	Manure management	44	43	43	44	45	45	44
	Rice cultivation	1.7	1.7	1.7	1.7	1.7	1.7	1.7
	Soil	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0
N_2O	Agriculture	**300**	**277**	**272**	**272**	**270**	**267**	**264**
	Enteric fermentation	0	0	0	0	0	0	0
	Manure management	34	29	27	28	27	26	25
	Rice cultivation	0	0	0	0	0	0	0
	Soil	266	247	245	245	243	241	238
	Other	0	0	0	0	0	0	0
Sum non-CO_2 GHG from agriculture		**521**	**476**	**461**	**461**	**455**	**448**	**439**

Table 4.8: Adjusted GAINS emission estimates for CH_4 and N_2O for the implementation of Agenda 2000 CAP Reform and the Nitrates Directive for the EU-25, taking account of national differences in emission factors [Mt CO_2 equivalent]

Gas		Year						
		1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture	**252**	**230**	**221**	**223**	**220**	**215**	**209**
	Enteric fermentation	179	161	153	153	149	145	139
	Manure management	70	66	66	68	69	68	67
	Rice cultivation	2.2	2.3	2.2	2.3	2.3	2.3	2.3
	Soil	-0.6	-0.5	-0.5	0	0	0	0
	Other	0.4	0.1	0.1	0	0	0	0
N_2O	Agriculture	**295**	**264**	**270**	**270**	**267**	**265**	**261**
	Enteric fermentation	0	0	0	0	0	0	0
	Manure management	29	26	31	32	31	30	30
	Rice cultivation	0	0	0	0	0	0	0
	Soil	265	238	238	238	236	234	231
	Other	0.7	0.6	0.6	0	0	0	0
Sum non-CO_2 GHG from agriculture		**547**	**494**	**491**	**493**	**487**	**480**	**470**

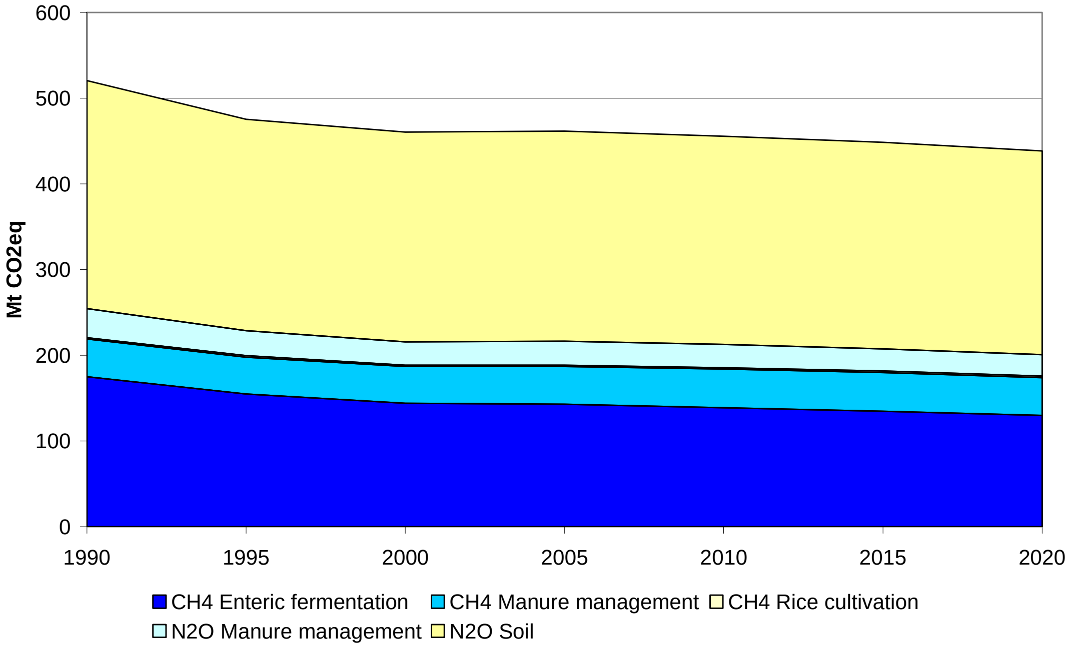

Figure 4.1: Agricultural greenhouse gas emissions of Scenario 1 in the EU-25 [MT CO_2eq], using GAINS emission factors

Table 4.9: GAINS emission estimates for CH_4 and N_2O for the implementation of Agenda 2000 CAP Reform and the Nitrates Directive for the old Member States (EU-15), using uniform emission factors [Mt CO_2 equivalent]

Gas			Year						
			1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture		**183**	**174**	**169**	**169**	**166**	**162**	**157**
		Enteric fermentation	143	134	127	126	123	119	115
		Manure management	39	39	40	41	42	41	41
		Rice cultivation	1.6	1.6	1.6	1.6	1.6	1.6	1.6
		Soil	0	0	0	0	0	0	0
		Other	0	0	0	0	0	0	0
N_2O	Agriculture		**247**	**236**	**232**	**230**	**227**	**224**	**219**
		Enteric fermentation	0	0	0	0	0	0	0
		Manure management	26	23	22	22	21	21	20
		Rice cultivation	0	0	0	0	0	0	0
		Soil	221	213	209	208	205	203	199
		Other	0	0	0	0	0	0	0
Sum non-CO_2 GHG from agriculture			**430**	**410**	**400**	**399**	**393**	**386**	**377**

Table 4.10: Adjusted GAINS emission estimates for CH_4 and N_2O for the implementation of Agenda 2000 CAP Reform and the Nitrates Directive for the old Member States (EU-15), taking account of national differences in emission factors

Gas			Year						
			1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture		**214**	**204**	**201**	**203**	**201**	**197**	**191**
		Enteric fermentation	147	140	137	136	133	129	124
		Manure management	65	63	63	65	66	65	64
		Rice cultivation	2.2	2.2	2.2	2.3	2.3	2.3	2.3
		Soil	-0.6	-0.5	-0.5	0	0	0	0
		Other	0.4	0.1	0.1	0	0	0	0
N_2O	Agriculture		**248**	**233**	**234**	**232**	**229**	**226**	**222**
		Enteric fermentation	0	0	0	0	0	0	0
		Manure management	25	23	23	23	22	21	21
		Rice cultivation	0	0	0	0	0	0	0
		Soil	222	209	210	210	207	205	201
		Other	0.7	0.6	0.6	0	0	0	0
Sum non-CO_2 GHG from agriculture			**462**	**437**	**435**	**436**	**430**	**423**	**413**

Table 4.11: GAINS emission estimates for CH_4 and N_2O for the implementation of Agenda 2000 CAP Reform and the Nitrates Directive for the new Member States (NMS-10), using uniform emission factors [Mt CO_2 equivalent]

Gas			Year						
			1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture		**37**	**25**	**20**	**20**	**19**	**19**	**19**
		Enteric fermentation	32	21	17	17	16	16	15
		Manure management	5	4	3	3	3	3	3
		Rice cultivation	0	0	0	0	0	0	0
		Soil	0	0	0	0	0	0	0
		Other	0	0	0	0	0	0	0
N_2O	Agriculture		**53**	**40**	**41**	**42**	**43**	**44**	**44**
		Enteric fermentation	0	0	0	0	0	0	0
		Manure management	8	6	5	5	5	5	5
		Rice cultivation	0	0	0	0	0	0	0
		Soil	45	34	36	37	38	38	39
		Other	0	0	0	0	0	0	0
Sum non-CO_2 GHG from agriculture			**91**	**65**	**61**	**62**	**62**	**62**	**63**

Table 4.12: Adjusted GAINS emission estimates for CH_4 and N_2O for the implementation of Agenda 2000 CAP Reform and the Nitrates Directive for the new Member States (NMS-10), taking account of national differences in emission factors

Gas			Year						
			1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture		**38**	**25**	**20**	**20**	**19**	**18**	**18**
		Enteric fermentation	33	22	17	17	16	15	15
		Manure management	5	4	3	3	3	3	3
		Rice cultivation	0.02	0.01	0.01	0.01	0.01	0.01	0.01
		Soil	0	0	0	0	0	0	0
		Other	0.04	0.03	0.03	0	0	0	0
N_2O	Agriculture		**47**	**32**	**37**	**38**	**38**	**39**	**39**
		Enteric fermentation	0	0	0	0	0	0	0
		Manure management	5	3	9	9	9	9	9
		Rice cultivation	0	0	0	0	0	0	0
		Soil	43	28	28	29	29	30	30
		Other	0.02	0.02	0.03	0	0	0	0
Sum non-CO_2 GHG from Agriculture			**85**	**57**	**56**	**58**	**57**	**57**	**57**

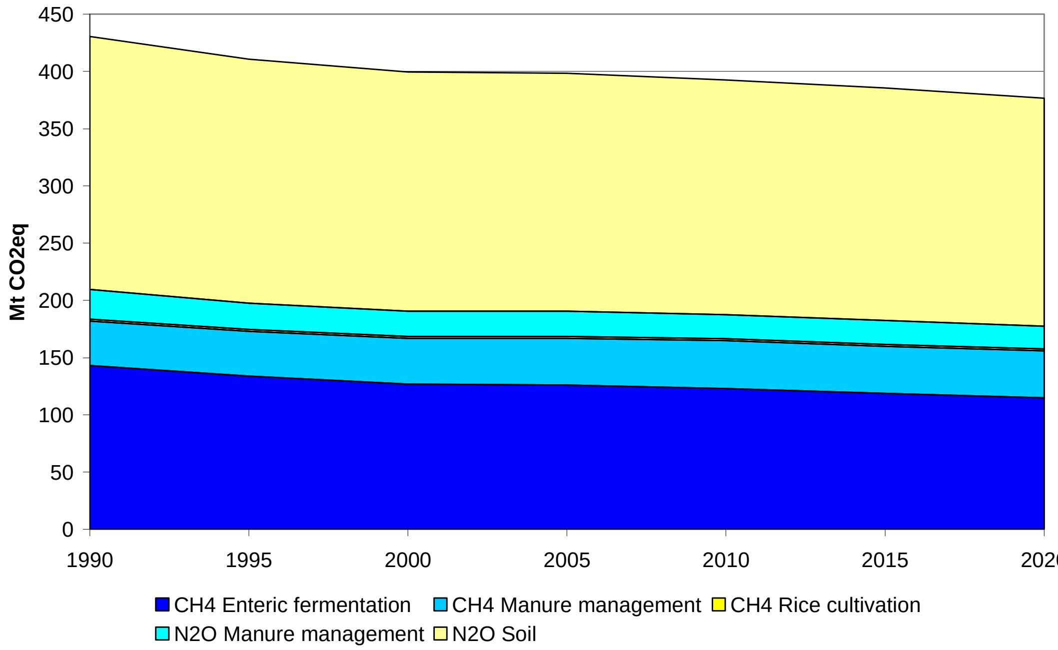

Figure 4.2: Agricultural greenhouse gas emissions of Scenario 1 in the EU-15 old Member States [MT CO_2eq], using GAINS emission factors

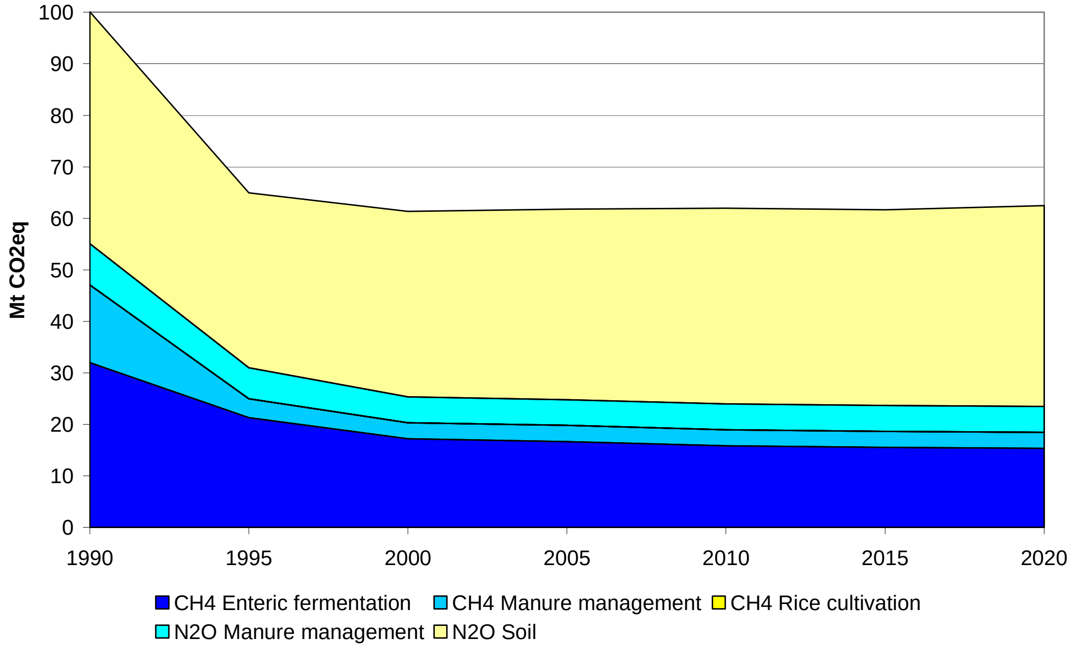

Figure 4.3: Agricultural greenhouse gas emissions of Scenario 1 in the NMS new Member States [MT CO_2eq], using GAINS emission factors

4.2.2 Scenario 2: Mid-term review CAP reform

On top of the emission reductions expected from the implementation of the Agenda 2000 CAP reform and the Nitrates Directive, non-CO_2 greenhouse gases in EU-25 are projected to decline by an additional four percentage points after implementation of the Mid-term review CAP reform. Both methane emissions from enteric fermentation and nitrous oxide emissions from soils are projected to decline by four additional percentage points due to the latest CAP reform.

Table 4.13: GAINS emission estimates for CH_4 and N_2O for the implementation of the Mid-term review CAP Reform for the EU-25, using uniform emission factors [Mt CO_2 equivalent]

Gas		Year						
		1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture	**221**	**199**	**189**	**182**	**177**	**175**	**173**
	Enteric fermentation	175	155	144	138	132	130	128
	Manure management	44	43	43	43	43	43	43
	Rice cultivation	1.7	1.7	1.7	1.7	1.7	1.7	1.7
	Soil	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0
N_2O	Agriculture	**300**	**277**	**272**	**262**	**258**	**257**	**255**
	Enteric fermentation	0	0	0	0	0	0	0
	Manure management	34	29	27	26	25	25	25
	Rice cultivation	0	0	0	0	0	0	0
	Soil	266	247	245	236	232	231	230
	Other	0	0	0	0	0	0	0
Sum non-CO_2 GHG from agriculture		**521**	**476**	**461**	**444**	**434**	**431**	**428**

Table 4.14: Adjusted GAINS emission estimates for CH_4 and N_2O for the implementation of Mid-term review CAP Reform for the EU-25, taking account of national differences in emission factors [Mt CO_2 equivalent]

Gas		Year						
		1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture	**252**	**230**	**221**	**215**	**209**	**206**	**203**
	Enteric fermentation	179	161	153	148	141	139	137
	Manure management	70	66	66	65	65	65	64
	Rice cultivation	2.2	2.3	2.2	2.3	2.3	2.3	2.3
	Soil	-0.6	-0.5	-0.5	0	0	0	0
	Other	0.4	0.1	0.1	0	0	0	0
N_2O	Agriculture	**295**	**264**	**270**	**262**	**257**	**256**	**254**
	Enteric fermentation	0	0	0	0	0	0	0
	Manure management	29	26	31	31	29	29	29
	Rice cultivation	0	0	0	0	0	0	0
	Soil	265	238	238	232	228	227	225
	Other	0.7	0.6	0.6	0	0	0	0
Sum non-CO_2 GHG from agriculture		**547**	**494**	**491**	**477**	**466**	**463**	**458**

Table 4.15: GAINS emission estimates for CH_4 and N_2O for the implementation of the Mid-term review CAP Reform for the old Member States (EU-15), using uniform emission factors [Mt CO_2 equivalent]

Gas		Year						
		1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture	**183**	**174**	**169**	**163**	**158**	**156**	**154**
	Enteric fermentation	143	134	127	121	117	115	113
	Manure management	39	39	40	40	40	40	40
	Rice cultivation	1.6	1.6	1.6	1.6	1.6	1.6	1.6
	Soil	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0
N_2O	Agriculture	**247**	**236**	**232**	**222**	**216**	**214**	**211**
	Enteric fermentation	0	0	0	0	0	0	0
	Manure management	26	23	22	21	20	20	20
	Rice cultivation	0	0	0	0	0	0	0
	Soil	221	213	209	200	196	194	191
	Other	0	0	0	0	0	0	0
Sum non-CO_2 GHG from agriculture		**430**	**410**	**400**	**385**	**375**	**371**	**366**

Table 4.16: Adjusted GAINS emission estimates for CH_4 and N_2O for the implementation of Mid-term review CAP Reform for the old Member States (EU-15), taking account of national differences in emission factors [Mt CO_2 equivalent]

Gas		Year						
		1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture	**214**	**204**	**201**	**196**	**191**	**188**	**185**
	Enteric fermentation	147	140	137	132	126	124	122
	Manure management	65	63	63	62	62	62	61
	Rice cultivation	2.2	2.2	2.2	2.3	2.3	2.3	2.3
	Soil	-0.6	-0.5	-0.5	0	0	0	0
	Other	0.4	0.1	0.1	0	0	0	0
N_2O	Agriculture	**248**	**233**	**234**	**225**	**219**	**217**	**214**
	Enteric fermentation	0	0	0	0	0	0	0
	Manure management	25	23	23	22	21	20	20
	Rice cultivation	0	0	0	0	0	0	0
	Soil	222	209	210	203	199	197	194
	Other	0.7	0.6	0.6	0	0	0	0
Sum non-CO_2 GHG from agriculture		**462**	**437**	**435**	**421**	**410**	**405**	**399**

Table 4.17: GAINS emission estimates for CH_4 and N_2O for the implementation of the Mid-term review CAP Reform for the new Member States (NMS-10), using uniform emission factors [Mt CO_2 equivalent]

Gas		Year						
		1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture	**37**	**25**	**20**	**19**	**19**	**19**	**19**
	Enteric fermentation	32	21	17	16	15	15	15
	Manure management	5	4	3	3	3	3	3
	Rice cultivation	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Soil	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0
N_2O	Agriculture	**53**	**40**	**41**	**41**	**41**	**42**	**43**
	Enteric fermentation	0	0	0	0	0	0	0
	Manure management	8	6	5	5	5	5	5
	Rice cultivation	0	0	0	0	0	0	0
	Soil	45	34	34	36	36	37	38
	Other	0	0	0	0	0	0	0
Sum non-CO_2 GHG from agriculture		**91**	**65**	**61**	**60**	**60**	**61**	**62**

Table 4.18: Adjusted GAINS emission estimates for CH_4 and N_2O for the implementation of the Mid-term review CAP Reform for the new Member States (NMS-10), taking account of national differences in emission factors [Mt CO_2 equivalent]

Gas		Year						
		1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture	**38**	**25**	**20**	**19**	**18**	**18**	**18**
	Enteric fermentation	33	22	17	16	15	15	15
	Manure management	4.9	3.6	2.9	2.9	3.0	3.0	3.0
	Rice cultivation	0.1	0	0	0	0	0	0
	Soil	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0
N_2O	Agriculture	**47**	**32**	**37**	**38**	**38**	**39**	**40**
	Enteric fermentation	0	0	0	0	0	0	0
	Manure management	4.7	3.3	8.7	8.6	8.6	8.7	8.8
	Rice cultivation	0	0	0	0	0	0	0
	Soil	43	28	28	29	30	30	31
	Other	0	0	0	0	0	0	0
Sum non-CO_2 GHG from agriculture		**85**	**57**	**56**	**57**	**56**	**57**	**58**

4.2.3 Scenario 3: National agricultural projections

Projections using activity data from national consultations predict similar reductions as in the Mid-term review CAP reform Scenario 2. Methane emissions from enteric fermentation and nitrous oxide emissions from soils are the principal sources with projected reductions of about four percentage points for each source beyond the reductions expected after implementation of the Agenda 2000 CAP reform and the Nitrates Directive in Scenario 1.

Table 4.19: GAINS emission estimates for CH_4 and N_2O for the national agricultural projections for the EU-25, using uniform emission factors [Mt CO_2 equivalent]

Gas			Year						
			1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture		**223**	**201**	**193**	**184**	**179**	**177**	**177**
		Enteric fermentation	176	155	146	137	132	130	129
		Manure management	46	44	45	45	45	46	46
		Rice cultivation	1.7	1.7	1.7	1.7	1.7	1.7	1.7
		Soil	0	0	0	0	0	0	0
		Other	0	0	0	0	0	0	0
N_2O	Agriculture		**309**	**281**	**281**	**271**	**266**	**264**	**263**
		Enteric fermentation	0	0	0	0	0	0	0
		Manure management	34	28	26	25	23	23	23
		Rice cultivation	0	0	0	0	0	0	0
		Soil	275	252	255	246	243	242	241
		Other	0	0	0	0	0	0	0
Sum non-CO_2 GHG from agriculture			**532**	**482**	**474**	**455**	**445**	**441**	**440**

Table 4.20: Adjusted GAINS emission estimates for CH_4 and N_2O for the national agricultural projections for the EU-25, taking account of national differences in emission factors [Mt CO_2equivalent]

Gas			Year						
			1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture		**252**	**230**	**221**	**212**	**207**	**204**	**203**
		Enteric fermentation	147	140	137	130	125	122	122
		Manure management	65	63	63	61	61	61	60
		Rice cultivation	2.2	2.2	2.2	2.3	2.3	2.3	2.3
		Soil	-0.6	-0.5	-0.5	0	0	0	0
		Other	0.4	0.1	0.1	0	0	0	0
N_2O	Agriculture		**295**	**264**	**270**	**260**	**255**	**253**	**252**
		Enteric fermentation	0	0	0	0	0	0	0
		Manure management	29	26	31	30	29	28	28
		Rice cultivation	0	0	0	0	0	0	0
		Soil	265	238	238	230	227	225	224
		Other	0.7	0.6	0.6	0	0	0	0
Sum non-CO_2 GHG from agriculture			**547**	**494**	**491**	**473**	**462**	**457**	**455**

Table 4.21: GAINS emission estimates for CH_4 and N_2O for the national agricultural projections for the old Member States (EU-15), using uniform emission factors [Mt CO_2 equivalent]

Gas			Year						
			1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture		**186**	**176**	**172**	**164**	**159**	**157**	**157**
		Enteric fermentation	144	134	128	121	116	114	114
		Manure management	40	40	42	41	41	41	41
		Rice cultivation	1.6	1.6	1.6	1.6	1.6	1.6	1.6
		Soil	0	0	0	0	0	0	0
		Other	0	0	0	0	0	0	0
N_2O	Agriculture		**248**	**235**	**236**	**225**	**220**	**218**	**217**
		Enteric fermentation	0	0	0	0	0	0	0
		Manure management	25	22	21	20	19	19	19
		Rice cultivation	0	0	0	0	0	0	0
		Soil	223	213	215	205	201	200	198
		Other	0	0	0	0	0	0	0
Sum non-CO_2 GHG from agriculture			**434**	**411**	**408**	**389**	**379**	**375**	**373**

Table 4.22: Adjusted GAINS emission estimates for CH_4 and N_2O for the national agricultural projections for the old Member States (EU-15), taking account of national differences in emission factors [Mt CO_2 equivalent]

Gas			Year						
			1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture		**214**	**204**	**201**	**194**	**188**	**185**	**184**
		Enteric fermentation	147	140	137	130	125	122	122
		Manure management	65	63	63	61	61	61	60
		Rice cultivation	2.1	2.2	2.2	2.3	2.3	2.3	2.3
		Soil	-0.6	-0.5	-0.5	0	0	0	0
		Other	0.4	0.1	0.1	0	0	0	0
N_2O	Agriculture		**248**	**233**	**234**	**223**	**218**	**216**	**214**
		Enteric fermentation	0	0	0	0	0	0	0
		Manure management	25	23	23	22	21	20	20
		Rice cultivation	0	0	0	0	0	0	0
		Soil	222	209	210	201	197	196	194
		Other	0.7	0.6	0.6	0	0	0	0
Sum non-CO_2 GHG from agriculture			**462**	**437**	**435**	**417**	**406**	**401**	**398**

Table 4.23: GAINS emission estimates for CH_4 and N_2O for the national agricultural projections for the new Member States (NMS-10), using uniform emission factors [Mt CO_2 equivalent]

Gas		Year						
		1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture	**37**	**25**	**21**	**20**	**20**	**20**	**20**
	Enteric fermentation	32	21	17	16	16	16	16
	Manure management	5.2	4.0	3.7	3.9	4.2	4.4	4.5
	Rice cultivation	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Soil	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0
N_2O	Agriculture	**60**	**46**	**45**	**45**	**46**	**46**	**46**
	Enteric fermentation	0	0	0	0	0	0	0
	Manure management	8.9	6.1	4.7	4.4	4.3	4.2	4.2
	Rice cultivation	0	0	0	0	0	0	0
	Soil	51	40	40	41	42	42	42
	Other	0	0	0	0	0	0	0
Sum non-CO_2 GHG from agriculture		**98**	**71**	**66**	**65**	**66**	**66**	**66**

Table 4.24: Adjusted GAINS emission estimates for CH_4 and N_2O for the national agricultural projections for the new Member States (NMS-10), taking account of national differences in emission factors [Mt CO_2 equivalent]

Gas		Year						
		1990	1995	2000	2005	2010	2015	2020
CH_4	Agriculture	**38**	**25**	**20**	**19**	**19**	**19**	**19**
	Enteric fermentation	33	22	17	16	16	15	15
	Manure management	4.9	3.6	2.9	3.0	3.3	3.4	3.4
	Rice cultivation	0.1	0	0	0	0	0	0
	Soil	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0
N_2O	Agriculture	**47**	**32**	**37**	**37**	**37**	**38**	**38**
	Enteric fermentation	0	0	0	0	0	0	0
	Manure management	4.7	3.3	8.7	8.3	8.0	7.8	7.9
	Rice cultivation	0	0	0	0	0	0	0
	Soil	43	28	28	29	29	30	30
	Other	0	0	0	0	0	0	0
Sum non-CO_2 GHG from agriculture		**85**	**57**	**56**	**56**	**56**	**56**	**57**

4.3 Emission changes by Member State

The GAINS model computes emission changes for all Member States of the European Union. Table 4.25 to Table 4.30 present for the three scenarios emission estimates for individual countries, using the two alternative calculation methods, and compares them with emission projections submitted by countries in their 2005 National Communications to the European Commission and the UNFCCC.

Breaking the reductions down by country, we find large differences in projected reductions in non-CO_2 greenhouse gases from the agricultural sector between Member States. For the new Member States (NMS-10) with recent economic transition, projected relative reductions since 1990 are generally large, between 15 and 63 percent in 2010 already before implementation of the Mid-term review CAP reform (Scenario 1). Only small additional reductions are projected after implementation of the Mid-term review CAP reform in Scenario 2 and 3.

For the old Member States (EU-15), reductions before implementation of the Mid-term review CAP reform (Scenario 1) are relatively large for Austria, Denmark, Finland, Germany, Greece, Luxembourg and the Netherlands with reductions ranging from 14 to 23 percent between 1990 and 2010. More moderate relative reductions (between 4 and 9 percent) are projected for Belgium, France, Italy, Sweden and the UK. For Ireland, Portugal and Spain, non-CO_2 greenhouse gases from agriculture are projected to increase before implementation of the latest CAP reform. After implementation of the Mid-term review CAP reform, largest additional reductions are projected to occur in Austria, Denmark, Finland, Germany, Italy, Portugal, Sweden and the UK. Spain and Cyprus are the only countries for which increases in emissions between 1990 and 2010 are projected even with the implementation of the latest CAP reform.

Table 4.25: Projected emissions of non-CO2 greenhouse gases from agriculture in 2010 [Mt CO2-eq.]

	GAINS methodology with uniform emission factors			Adjusted GAINS estimates with national emission factors			National estimates
	Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3	Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National agricultural projections Scenario 3	National communication to UNFCCC 2005[2])
Austria	7.3	6.8	6.7	7.7	7.1	6.9	7.3
Belgium	11.5	11.6		12.2	12.3		11.5
Cyprus	0.7	0.7		0.7	0.7		
Czech Rep.	8.6	9.3	9.1	7.1	7.7	7.5	7.6
Denmark	11.4	10.7	10.9	10.0	9.4	9.5	9.5
Estonia	1.4	1.3	1.3	1.0	0.9	0.9	
Finland	6.1	5.7	5.3	5.6	5.3	4.9	4.7
France	82.9	82.3	82.3	103.1	102.1	98.7	
Germany	67.1	63.0		89.2	83.3		
Greece	9.6	9.3		11.8	11.4		12.3
Hungary	8.6	8.2	9.0	10.7	10.2	11.6	
Ireland	18.0	16.4	18.1	20.3	18.5	17.3	
Italy	44.2	40.1	45.2	39.6	36.1	40.9	36.1
Latvia	2.1	1.8	2.3	1.7	1.4	1.6	
Lithuania	6.5	4.5		2.9	2.8		1.7
Luxembourg	0.6	0.6		0.3	0.3		
Malta	0.1	0.1		0.1	0.1		
Netherlands	19.7	19.7	18.4	18.6	18.7	17.4	17.2-18.4
Poland	29.3	28.9	33.8	26.8	26.1	24.5	
Portugal	7.8	6.8	8.7	8.9	8.2	8.8	11.2-12.3
Slovakia	2.9	3.4		4.0	4.6		2.3-2.8
Slovenia	1.7	1.7	1.8	2.1	1.9	2.1	
Spain	45.4	46.0		41.9	42.5		
Sweden	9.1	8.6	8.5	8.9	8.4	8.2	8.1
UK	52.3	46.9	44.8	52.0	46.5	43.5	43.6
EU-25	455	434	445[1)]	487	466	462[1)]	
EU-15	393	375	379[1)]	430	410	406[1)]	
NMS-10	62	60	66[1)]	57	56	56[1)]	

1) Assuming data of Scenario 2 for countries who have not supplied projections.

2) Using national calculation method. Numbers are shown as reported to UNFCCC, if necessary converted to CO_2 –eq.

Table 4.26: Changes in non-CO_2 greenhouse gas emissions from agriculture between 1990 and 2010 (in percent)

	GAINS methodology with uniform emission factors			Adjusted GAINS estimates with national emission factors			National estimates
	Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3	Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National agricultural projections Scenario 3	National communication to UNFCCC 2005[2])
Austria	-16.1 %	-22.7 %	-24.7	-9.4 %	-16.5 %	-18.8 %	-14.2 %
Belgium	-4.2 %	-3.3 %		-4.7 %	-3.9 %		[3])
Cyprus	+16.7 %	+16.7 %		+16.7 %	+16.7 %		
Czech Rep.	-35.8 %	-30.6 %	-37.7	-43.2 %	-38.4 %	-40.0 %	[3])
Denmark	-16.2 %	-21.3 %	-19.9	-21.9 %	-26.6 %	-25.8 %	-26.5 %
Estonia	-62.2 %	-64.9 %	-58.1	-58.3 %	-62.5 %	-62.5 %	
Finland	-14.1 %	-21.9 %	-29.3	-18.8 %	-23.2 %	-29.0 %	[3])
France	-7.6 %	-8.2 %	-10.2	-4.3 %	-5.2 %	-8.4 %	
Germany	-16.7 %	-21.8 %		-18.2 %	-23.6 %		
Greece	-23.2 %	-25.6 %		-12.6 %	-15.6 %		-20.1 %
Hungary	-24.6 %	-28.1 %	-21.1	-34.8 %	-37.8 %	-29.3 %	
Ireland	+0.6 %	-8.4 %	-7.2	+10.3 %	+0.5 %	-6.0 %	
Italy	-4.9 %	-11.9 %	-0.7	-2.5 %	-11.1 %	+0.7 %	-11.1 %
Latvia	-63.2 %	-68.4 %	-62.9	-67.3 %	-73.1 %	-69.2 %	
Lithuania	-33.7 %	-54.1%		-59.2 %	-60.6 %		[3])
Luxembourg	-14.3 %	-14.3 %		-40.0 %	-40.0 %		
Malta	0 %	0 %		0 %	0 %		
Netherlands	-17.9 %	-17.9 %	-23.3 %	-14.7 %	-14.2 %	-20.2 %	-16.0-21.5%
Poland	-21.2 %	-22.3 %	-21.2 %	-12.1 %	-14.4 %	-19.7 %	
Portugal	+2.6 %	-10.5 %	+2.4 %	0 %	-7.9 %	-1.1 %	-0-9 %
Slovakia	-57.4 %	-50.0 %		-50.6 %	-43.2 %		-71.1-73.6%
Slovenia	-15.0 %	-15.0 %	-10.0 %	-8.7 %	-17.4 %	-8.7 %	
Spain	+8.1 %	+9.5 %		+12.0 %	+13.6 %		
Sweden	-6.2 %	-11.3 %	-12.4 %	-7.3 %	-12.5 %	-14.6 %	-15.4 %
UK	-9.0 %	-18.4 %	-22.1 %	-2.6 %	-12.9 %	-18.5 %	-22.7 %
EU-25	-12.7 %	-16.5 %	-16.4 % [1])	-11.0 %	-14.8 %	-15.5 % [1])	
EU-15	-8.6 %	-12.6 %	-12.7 % [1])	-6.9 %	-11.3 %	-12.1 % [1])	
NMS-10	-31.9 %	-34.1 %	-32.7 % [1])	-32.9 %	-34.1 %	-34.1 % [1])	

[1]) Assuming data of Scenario 2 for countries who have not supplied projections.

[2]) Using national calculation method.

[3]) No data for 1990 given in National Communication

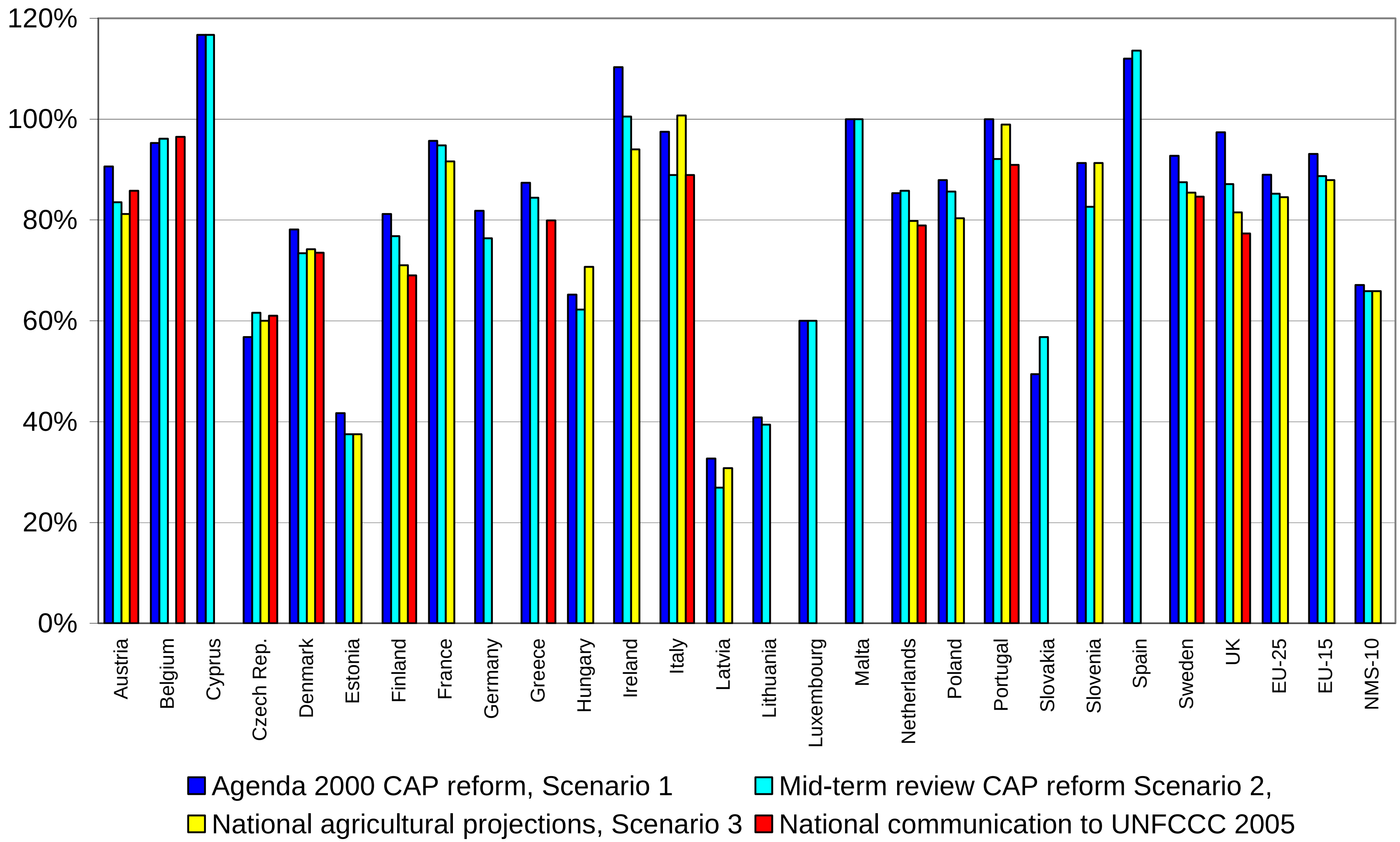

Figure 4.4: Agricultural emissions in 2010 by Member State relative to 1990 (converted to CO_2eq)

Table 4.27: Projected emissions of non-CO_2 greenhouse gases from agriculture in 2015 [Mt CO_2-eq.]

	GAINS methodology with uniform emission factors			Adjusted GAINS estimates with national emission factors			National estimates
	Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3	Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National agricultural projections Scenario 3	National communication to UNFCCC 2005[2])
Austria	7.2	6.7	6.6	7.6	7.0	6.9	7.3
Belgium	11.3	11.6		12.0	12.3		11.3
Cyprus	0.7	0.7		0.7	0.7		
Czech Rep.	8.6	9.5	9.1	7.1	7.9	7.5	7.7
Denmark	11.2	10.6	10.6	9.8	9.2	9.2	9.1
Estonia	1.5	1.3	1.2	1.0	0.9	0.8	
Finland	6.0	5.6	5.2	5.5	5.1	4.7	4.4
France	81.0	81.9	82.1	100.9	101.8	98.5	
Germany	66.0	61.2		87.9	80.6		
Greece	9.5	9.3		11.6	11.4	11.4	12.4
Hungary	8.7	8.5	9.4	10.8	10.5	12.1	
Ireland	17.4	16.1	17.5	19.7	18.2	16.8	
Italy	43.5	39.7	45.3	39.0	35.7	41.0	36.1
Latvia	2.2	1.8	2.3	1.8	1.4	1.6	
Lithuania	6.6	4.5		2.9	2.7		1.7
Luxembourg	0.6	0.6		0.3	0.3		
Malta	0.1	0.1		0.1	0.1		
Netherlands	19.4	19.2	19.0	18.3	18.2	17.9	16.8-18.3
Poland	29.3	29.5	33.4	26.7	26.5	24.0	
Portugal	7.7	6.7	7.8	8.8	8.0	7.7	
Slovakia	2.9	3.4		4.0	4.7		2.1-2.7
Slovenia	1.7	1.7	1.8	2.0	2.0	2.1	
Spain	44.7	46.7		41.2	43.2		
Sweden	9.0	8.6	8.5	8.7	8.4	8.2	8.1
UK	51.5	46.3	43.4	51.3	46.0	42.2	43.6
EU-25	448	431	441 *)	480	463	457 *)	
EU-15	386	371	375 *)	422	405	401 *)	
NMS-10	62	61	66 *)	57	57	56 *)	

*) Assuming data of Scenario 2 for countries who have not supplied projections.

2) Using national calculation method. Numbers are shown as reported to UNFCCC, if necessary converted to CO_2 –eq.

Table 4.28: Changes in non-CO_2 greenhouse gas emissions from agriculture between 1990 and 2015 (in percent)

	GAINS methodology with uniform emission factors			Adjusted GAINS estimates with national emission factors		
	Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3	Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3
Austria	-17.2 %	-23.9 %	-25.8 %	-10.6 %	-17.6 %	-18.8 %
Belgium	-5.8 %	-3.3 %		-6.3 %	-3.9 %	
Cyprus	+16.7 %	+16.7 %		+16.7 %	+16.7 %	
Czech Rep.	-35.8 %	-29.1 %	-37.7 %	-43.2 %	-36.8 %	-40.0 %
Denmark	-17.6 %	-22.1 %	-22.1 %	-23.4 %	-28.1 %	-28.1 %
Estonia	-59.5 %	-64.9 %	-61.3 %	-58.3 %	-62.5 %	-66.7 %
Finland	-15.5 %	-23.3 %	-30.7 %	-20.3 %	-26.1%	-31.9 %
France	-9.7 %	-8.7 %	-10.4 %	-6.3 %	-5.5 %	-8.5 %
Germany	-18.1 %	-24.1 %		-19.4 %	-26.1 %	
Greece	-24.0 %	-25.6 %		-14.1%	-15.6 %	
Hungary	-23.7 %	-25.4 %	-17.5%	-34.1 %	-36.0 %	-26.2 %
Ireland	-2.8 %	-10.1 %	-10.3 %	+7.1 %	-1.1 %	-8.7 %
Italy	-6.5 %	-12.7 %	-0.4 %	-3.9 %	-12.1 %	+1.0 %
Latvia	-61.4 %	-68.4 %	-62.9 %	-65.4 %	-73.1 %	-69.2 %
Lithuania	-32.7 %	-54.1 %		-59.2 %	-62.0 %	
Luxembourg	-14.3 %	-14.3 %		-40.0 %	-40.0%	
Malta	0 %	0 %		0 %	0 %	
Netherlands	-19.2 %	-20.0 %	-20.8 %	-16.1 %	-16.5 %	-17.9 %
Poland	-21.2 %	-20.7 %	-22.1 %	-12.5 %	-13.1 %	-21.3 %
Portugal	+1.3 %	-11.8 %	+8.2 %	-1.1 %	-10.1 %	-13.5 %
Slovakia	-57.4 %	-50.0 %		-50.6 %	-42.0 %	
Slovenia	-15.0 %	-15.0 %	-10.0 %	-13.0 %	-13.0 %	-8.7 %
Spain	+6.4 %	+11.2 %		+10.2 %	+15.5 %	
Sweden	-7.2 %	-11.3 %	-12.4 %	-9.4 %	-12.5 %	-14.6 %
UK	-10.4 %	-19.5 %	-24.5 %	-3.9 %	-13.9 %	-21.0 %
EU-25	-14.0 %	-17.1 %	-17.1 % *)	-12.2 %	-15.4 %	-16.5 % *)
EU-15	-10.2 %	-13.5 %	-13.6 % *)	-8.7 %	-12.3 %	-13.2 % *)
NMS-10	-31.9 %	-33.0 %	-32.7 % *)	-32.9 %	-32.9 %	-34.1 % *)

*) Assuming data of Scenario 2 for countries who have not supplied projections.

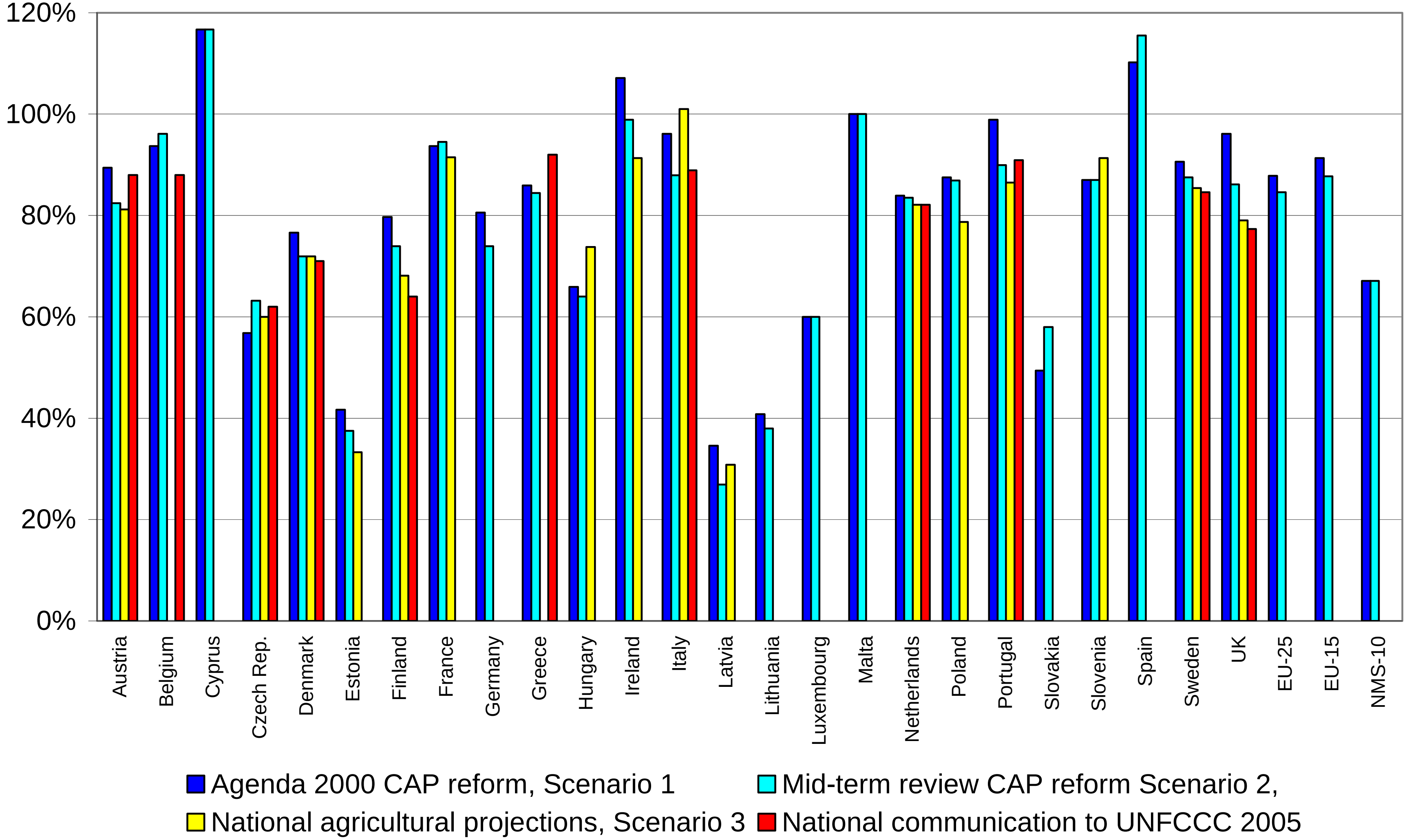

Figure 4.5: Agricultural emissions in 2015 by Member State relative to 1990 (converted to CO_2eq)

Table 4.29: Projected emissions of non-CO_2 greenhouse gases from agriculture in 2020 [Mt CO_2-eq.]

	GAINS methodology with uniform emission factors			Adjusted GAINS estimates with national emission factors			National estimates
	Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3	Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National agricultural projections Scenario 3	National communication to UNFCCC 2005 2)
Austria	7.1	6.6	6.6	7.4	6.9	6.9	7.4
Belgium	11.0	11.5		11.7	12.3		11.0
Cyprus	0.7	0.7		0.7	0.7		
Czech Rep.	8.6	9.7	9.2	7.1	8.1	7.5	7.7
Denmark	11.0	10.4	10.4	9.6	9.1	9.1	8..9
Estonia	1.6	1.3	1.3	1.0	0.8	0.9	
Finland	5.9	5.5	4.6	5.4	5.0	4.1	4.3
France	78.6	81.8	81.4	98.2	101.6	97.6	
Germany	64.5	59.2		86.0	77.8		
Greece	9.2	9.2		11.3	11.3		12.6
Hungary	8.7	8.7	9.7	10.9	10.7	12.6	
Ireland	16.8	15.5	17.5	19.0	17.5	16.8	
Italy	42.6	39.1	45.4	38.1	35.1	41.1	36.1
Latvia	2.4	1.7	2.3	1.9	1.4	1.6	
Lithuania	6.7	4.5		3.0	2.7		1.7
Luxembourg	0.6	0.6		0.3	0.3		
Malta	0.1	0.1		0.1	0.1		
Netherlands	18.8	18.3	19.6	17.8	17.3	18.5	16.2-19.2
Poland	29.4	30.1	33.4	26.7	27.0	23.9	
Portugal	7.6	6.5	7.6	8.6	7.8	7.5	
Slovakia	2.9	3.5		4.0	4.7		2.0-2.8
Slovenia	1.7	1.7	1.8	2.0	2.0	2.1	
Spain	43.6	47.8		40.2	44.3		
Sweden	8.8	8.5	8.5	8.5	8.3	8.2	8.1
UK	50.4	45.0	43.6	50.3	44.7	42.4	43.6
EU-25	439	428	440 *)	470	458	455 *)	
EU-15	377	366	373 *)	412	399	398 *)	
NMS-10	63	62	66 *)	57	58	57 *)	

*) Assuming data of Scenario 2 for countries who have not supplied projections.

2) Using national calculation method. Numbers are shown as reported to UNFCCC, if necessary converted to CO_2 –eq.

Table 4.30: Changes in non-CO_2 greenhouse gas emissions from agriculture between 1990 and 2020 (in percent)

	GAINS methodology with uniform emission factors			Adjusted GAINS estimates with national emission factors		
	Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3	Agenda 2000 CAP reform Scenario 1	Mid-term review CAP reform Scenario 2	National projections Scenario 3
Austria	-18.4 %	-25.0 %	-25.8 %	-12.9 %	-18.8 %	-18.8 %
Belgium	-8.3 %	-4.2 %		-8.6 %	-3.9 %	
Cyprus	+16.7 %	+16.7 %	+16.7 %	+16.7 %	+16.7 %	+16.7 %
Czech Rep.	-35.8 %	-27.6 %	-37.0 %	-43.2 %	-35.2 %	-40.0 %
Denmark	-19.1 %	-23.5 %	-23.5 %	-25.0 %	-28.9 %	-28.9 %
Estonia	-56.8 %	-64.9 %	-58.1 %	-58.3 %	-66.7 %	-62.5 %
Finland	-16.9 %	-24.7 %	-38.7 %	-21.7 %	-27.5 %	-40.6 %
France	-12.4 %	-8.8 %	-11.1 %	-8.8 %	-5.7 %	-9.4 %
Germany	-20.0 %	-26.6 %		-21.2 %	-28.7 %	
Greece	-26.4 %	-26.4 %		-16.3 %	-16.3 %	
Hungary	-23.7 %	-23.7 %	-14.9 %	-33.5 %	-34.8 %	-23.2 %
Ireland	-6.1 %	-13.4 %	-10.3 %	+3.3 %	-4.9 %	-8.7 %
Italy	-8.4 %	-14.1 %	-0.2 %	-6.2 %	-13.5 %	+1.2 %
Latvia	-57.9 %	-70.2 %	-62.9 %	-63.5 %	-73.1 %	-69.2 %
Lithuania	-31.6 %	-54.1 %		-57.7 %	-62.0 %	
Luxembourg	-14.3 %	-14.3 %		-40.0 %	-40.0 %	
Malta	0 %	0 %		0 %	0 %	
Netherlands	-21.7 %	-23.8 %	-18.3 %	-18.3 %	-20.6 %	-15.1 %
Poland	-21.0 %	-19.1 %	-22.1 %	-12.5 %	-11.5 %	-21.6 %
Portugal	0 %	-14.5 %	-10.6 %	-3.4 %	-12.4 %	-15.7 %
Slovakia	-57.4 %	-48.5 %		-50.6 %	-42.0 %	
Slovenia	-15.0 %	-15.0 %	-10.0 %	-13.0 %	-13.0 %	-8.7 %
Spain	+3.8 %	+13.8 %		+7.5 %	+18.4 %	
Sweden	-9.3 %	-12.4 %	-12.4 %	-11.5 %	-13.5 %	-14.6 %
UK	-12.3 %	-21.7 %	-24.2 %	-5.8 %	-16.3 %	-20.6 %
EU-25	-15.7 %	-17.7 %	-17.3 % *)	-14.1 %	-16.3 %	-16.8 % *)
EU-15	-12.3 %	-14.7 %	-14.1 % *)	-10.8 %	-13.6 %	-13.9 % *)
NMS-10	-30.8 %	-31.9 %	-32.7 % *)	-32.9 %	-31.8 %	-32.9 % *)

*) Assuming data of Scenario 2 for countries who have not supplied projections.

4.4 Comparison to the ECCP-I results for the EU-15 countries

The baseline scenario developed within the first phase of the ECCP (EC, 2003) showed for EU-15 a reduction of agricultural GHG emissions by about 19 Mt CO_2 eq. by 2010 compared to 1990. Furthermore, the study provided a thorough overview of abatement measures and their reduction and costs. Finally that study proposed a set of recommended measures that would allow for further reduction of greenhouse gases from agriculture by 12 Mt CO_2eq., for which costs have been judged as acceptable. Out of this, the major potential was identified for lowering N_2O emissions from soils (about 10 Mt), followed by anaerobic digestion (1.7 Mt) and enteric fermentation (0.3 Mt). The total potential for reduction of GHG from agriculture was estimated at 31 Mt CO_2eq. by 2010 compared to 1990. This is illustrated in **Error! Reference source not found.** as ECCP-I lines.

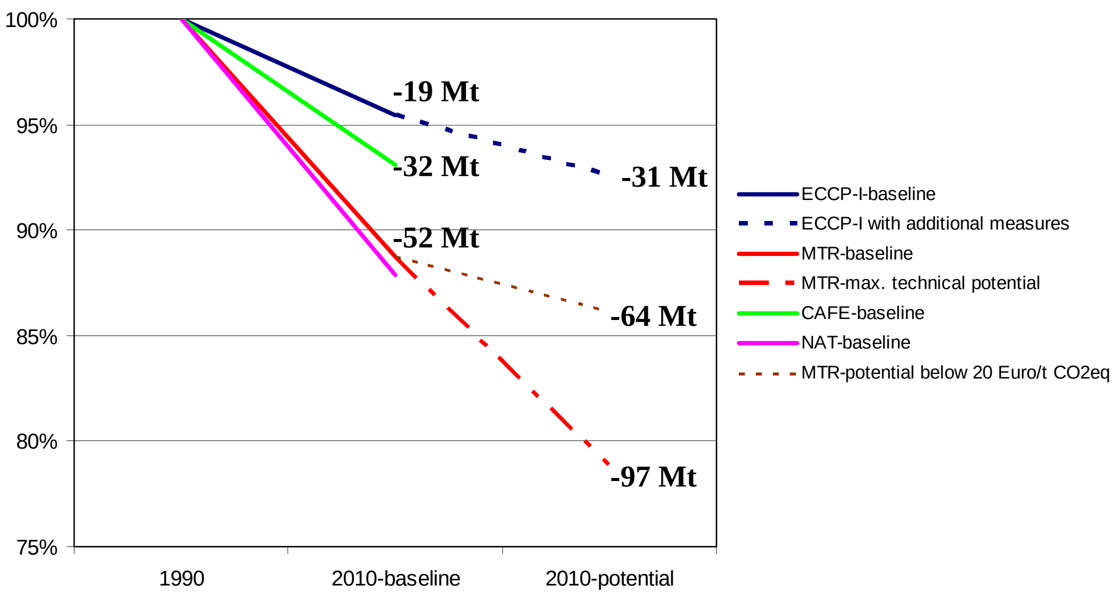

Figure 4.6: Comparison of the baselines and potential reductions estimated within ECCP-I and the current GAINS scenarios (reduction relative to 1990, Mt CO_2 eq.)

The new mid-term review (MTR) and the national (NAT) agricultural projections analyzed in this study would lead in 2010 to a decline of agricultural GHG emissions by 12-13 percent compared to 1990 without further measures. This autonomous reduction is significantly higher than the potential seen for the ECCP-1 programme, even with the further measures that have been considered as economically viable. These new estimates are consistent with the trends reported in the recent National Communications to UNFCCC, which show for the period between 1990 and 2003 a decline of about 10 percent. A simple extrapolation would suggest to 2010 a 13 percent reduction.

On top of these autonomous changes, the GAINS database contains additional measures that could further reduce agricultural greenhouse gas emissions, though at higher costs (see Höglund and Mechler, 2005; Winiwarter, 2005)

It is estimated that GHG emissions could be further reduced by about 12 Mt CO_2eq in the EU-15 for costs below 20 €/t CO_2eq. Measures would include a full introduction of farm-scale anaerobic digesters. Thereby, agricultural GHG emissions would decline by about 14 percent compared to 1990, which is fairly consistent with extrapolated historic emission trends and the country-specific additional measures as reported in the National Communications.

The GAINS model contains further measures that could lead, at higher costs, to additional emission reductions. For the new agricultural projections the model identifies a technical potential for further reductions of about 33 Mt CO_2eq. for costs exceeding 20 €/t CO_2eq., so that emissions could be reduced by 22 percent below the 1990 level. Considering country-specific limits to the application potentials for the various measures, one third of the reduction potential is linked to methane emissions. The remaining potential exists for soil N_2O emissions, primarily through application of nitrification inhibitors and, to a lesser extent, from further implementation of precision farming that would allow lower application rates for N-fertilizers.

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5 Conclusions

This report presents three sets of emission projections of the non-CO_2 greenhouse gases methane and nitrous oxide from agricultural sources in the EU until 2020 based on three recent sets of scenarios of future agricultural activities in the EU.

All scenarios suggest for the EU-25 for the coming decades a significant decline of agricultural non-CO_2 greenhouse gas emissions compared to the base year 1990, mainly as a consequence of declining cattle numbers due to productivity increases in milk and beef production and more efficient application of fertilizers. The exact magnitude of the decline will depend on the assumed agricultural policy as well as on specific national conditions.

For the first scenario (i.e., CAFE projections reflecting the impacts of the Agenda 2000 CAP reform and the Nitrates Directive), an 11-13 percent decline of agricultural emissions from the EU-25 is estimated for the period 1990 to 2010, depending on the calculation methodology. The changes in livestock numbers and fertilizer use implied by the 2003 Mid-term review of the CAP reform and the EU sugar reform would reduce non-CO_2 greenhouse gas emissions further by approximately four percentage points. Based on the national projections of livestock numbers and fertilizer use as provided in 2005 by the Member States for the NEC revision, agricultural non-CO_2 greenhouse gases are computed to decline by approximately 16 percent up to 2010.

These trends show significant variations across Member States. Emissions from the old Member States (EU-15) are calculated to decline by between 7 to 13 percent, depending on the agricultural scenario and calculation method. For the new Member States (NMS-10), reductions between 32 and 35 percent are estimated.

On a CO_2-equivalent basis, slightly more than half of the reductions result from N_2O, while methane changes would account for approximately 45 percent.

More than half of the expected reductions between 1990 and 2010 have occurred between 1990 and 1995, mainly due to the structural changes in the New Member States. Scenario 1 results in four percent additional emission reductions between 1995 and 2010, while the Mid-term CAP review Scenario 2 and the national projections suggest an eight percent further decline between 1995 and 2010. Beyond 2010 up to 2020, both projections indicate a further decline by approximately two percentage points due to ongoing changes in the agricultural sector in Europe.

In comparison to the ECCP-I baseline, the scenarios presented in this study indicate larger reductions by 2010, i.e., up to 14 percent reduction vs. about five percent estimated previously, compared to the 1990 level. This is consistent with trends that could be derived from the most recent country submissions to National Communications, which demonstrate a reduction of GHG emissions from agriculture by about 12-13 percent between 1990 and 2003.

GAINS estimates a technical potential for reductions of greenhouse gases from agriculture in the EU-15 of about 22 percent compared to the 1990 emissions (or 97 Mt CO_2eq.); 52 Mt CO_2eq. originate from the new baseline projection, 12 Mt CO_2eq. could be reduced for costs of less than 20 €/t CO_2eq., while exhausting the full technical potential (at higher costs) would bring reductions of additional 33 Mt CO_2eq.

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